

See discussions, stats, and author profiles for this publication at: <https://www.researchgate.net/publication/228751427>

Education for sustainability in the built environment: What are students telling US?

Article · January 2012

CITATIONS

7

READS

576

3 authors, including:



[Usha Iyer-Raniga](#)

RMIT University

47 PUBLICATIONS 761 CITATIONS

[SEE PROFILE](#)

Some of the authors of this publication are also working on these related projects:



Sustainable Development Research in the Asia Pacific [View project](#)



Climate Resilient Honiara [View project](#)

EDUCATION FOR SUSTAINABILITY IN THE BUILT ENVIRONMENT: WHAT ARE STUDENTS TELLING US?

Usha Iyer-Raniga¹, Paula Arcari² and James PC Wong²

1 School of Property, Construction and Project Management & Centre for Design, RMIT University, GPO Box 2476, Victoria 3001, Australia

2 Centre for Design, RMIT University, GPO Box 2476, Victoria 3001, Australia

There is no doubt that climatic changes are affecting humans and will continue to do so over this century. As the evidence for climate change caused by humans is mounting, there are attendant pressures on how changes can be made to the way humans live and work. Education for sustainability is an important part of the journey to live and work in a sustainable manner.

Curricula changes to incorporate sustainability education in the built environment disciplines is not a new phenomenon. Often, curricula changes are made from the perspective of the discipline and the individual teaching the subject, with very little engagement with students on whether the knowledge is 'pitched' at the right level. While most universities undertake their standard course evaluation surveys, the focus of the research reported in this paper is to go beyond the standard evaluation surveys.

The research is focused on RMIT students graduating in Construction Management in Melbourne and Singapore. The aim of the study is two fold: to investigate whether students are aware of the importance of sustainability education in their working lives and whether there are any difference in the way students in Melbourne and Singapore view sustainability education.

Accordingly, two cohorts of undergraduate students undertook the voluntary survey, one in Melbourne and one in Singapore. Evaluation of the results show that there does not appear to be significant differences in the perceptions, knowledge and understanding of sustainability issues amongst Melbourne and Singapore students of Property, Construction and Project Management at RMIT University. This is logical as the course curricula in the two cohorts of students are similar, but adapted to introduce local knowledge and information. Findings from this study have pedagogical implications for teaching students in the built environment disciplines.

Keywords: construction, education, sustainability, Australia.

INTRODUCTION

Fossil fuels are the engines of the building and construction industry. Over 80% of the world's energy is currently sourced from finite fossil fuels – oil, natural gas and coal (EIA 2009a). Due to population increase, economic growth and development,

¹ Usha.Iyer-Raniga@rmit.edu.au

global energy consumption is projected to increase 44% by 2030, with just 2% of this increase expected to be met by renewable energy (EIA 2009b). Energy consumption leads to attendant emissions of greenhouse gases, which causes inherent risks to the earth and to humanity if these emissions are not curbed (IPCC 2007). It is estimated that 40-50% of the energy, and 16% of the water used annually worldwide is attributable to the building industry (Langston and Langston 2008; OECD 2003).

In Australia, energy use from the manufacturing and construction sector is increasing at an annual rate of 1.2% with a predicted overall increase of 36% by 2030 (ABARE 2006). Energy used in buildings accounts for almost 27% of all energy related greenhouse gas emissions in Australia (Australian Building Codes Board, in Holloway and Bunker 2006) and building stock is increasing at an annual rate of 3.8% (DEH 2006). Going forward, a dramatic increase in the resource intensity of the industry is anticipated (Langston and Langston 2007). The building industry therefore needs to find ways to halt and reverse the annual increase in energy demand urgently.

Role of education

Building and construction professionals are responsible for creating the landscapes that, to a large extent, govern how we live and behave. Despite being in a leadership position, the prevalent message is that the building industry lags far behind others in terms of sustainability, has been slow to embrace environmentally friendly practices and, furthermore, is often actively resistant partly due to gross inefficiencies that persist in a traditionally fragmented industry that is commonly perceived as “dirty, dangerous and old-fashioned” (Fairclough 2002 in Myers 2005; Russell et al. 2007).

This leads to the question of where are the points of intervention to improve the sustainability practices and outcomes of the construction industry. External controls through building codes and regulations are one such point and may well be a driver in the future. Internally, the main point of intervention is through the industry’s key resource – its people – as they play a critical role in either maintaining/enforcing the status quo or instigating change (Howarth and Griffith 1998). Higher education is essentially the ‘provider’ of this resource and therefore educational institutions need to think about whether or not they are producing graduates capable of, and motivated to be instigators of change.

STATE OF PLAY

Reviewed literature covering education and the construction industry is categorised into studies that include sustainability as a focus of research, and those that make little or no reference to it. Each of these is examined in greater detail below.

Sustainability Focus

The literature within this group is characterised by approaches where sustainability is seen as deep/core knowledge and understanding to create agents of change; and discrete and voluntary course elements built around specific topics.

The UK appears to be most aware of the shortcomings of current practices in the building industry and several organizations, including the UK Environment Agency and the Chartered Institute of Building, have produced reports quantifying the problems and advocating for reform (CIOB 2004; EA 2001). Ganah et al. (2008) highlight that the role of educational institutions is not simply to produce skilled

labour to match job gaps, but also to contribute to the transfer of research knowledge to benefit industry and the community.

At La Trobe University in Australia, the ultimate intention of preliminary curriculum reforms in civil engineering is to develop a sustainability theme across all levels of the university's educational processes (Russell et al. 2009). Since 2009, at least a quarter of required courses each year are focused on sustainability. A focus on problem-solving skills and a multi-disciplinary approach to project planning are further fostered in the 'Futuristic Reports' element of the course, which aims to equip graduates to work in a "rapidly changing environment, facing issues of climate change, resource limitation, and embodied energy and water" (Russell et al. pp 793).

A US study acknowledges that current environmental and social concerns necessitate a paradigm shift in the construction industry and the key to achieving this is through educational reform (Wang 2009). However, based on a single course module, findings do not indicate whether students have acquired a deeper understanding of sustainability beyond techniques, technologies and tools, or the ability to think critically and with awareness about the consequences of their decisions.

Sustainability Not Included/Marginal

The literature within this category is characterised by industry as the key driver of educational outcomes, education as the driver of change in industry, and the role of education being to foster emotional intelligence.

Several studies focus on improving educational practices to better serve, rather than challenge or change the industry (Manthe and Smallwood 2007; Miller 2005; Williams 2004). The latter UK study advocates a "customer focused business" where students learn construction practice directly from the industries to "better understand their job and the needs of the business". Sustainability is not acknowledged, or the fact that industry involvement may lead to the perpetuation of inappropriate practices.

While viewing education as "a supplier to industry", a UK study also considers its role as producing graduates with the ability to "contribute positively to society in moral, social and economic terms" (Hill et al. 1997, pp 525, 527). A study of emotional intelligence (EI) found that students of construction management displayed lower levels of emotional intelligence (EI) compared with other professions and that EI "is crucial to both construction education and construction professionals' future effectiveness and success" (Mo et al. 2007, pp 331).

Industry indications and future trends

Little research to date has focused on the attitude of the construction industry to sustainability. One exception is an analysis of public disclosures from 42 major construction companies (Europe-based and multinationals) (Myers 2005). The study notes a lack of respect for sustainability in the construction industry, persistent fragmentation, a need for a more ethical sustainability profile, and for social and environmental benefits to be seen as compatible with lower costs and higher profits.

Along similar lines, a study of UK construction industry leaders found that they were largely motivated by personal agendas, with unethical behaviour and breaches in professional responsibilities prevalent in the industry as a whole (Elmualim 2008). These studies incorporate major multinationals and the findings therefore present a current state of play that it can be assumed applies equally to Australia or other countries in the Asia-Pacific region.

Worldwide, the engineering sector has been more forthcoming in its acknowledgment of sustainability and efforts to change industry practices (WFEO 2006; ASCE 2004 in Wang 2010). In Australia, professional engineering and construction sectors do not appear to have adopted similar policies or objectives. However, education institutions are taking up the call for industry change (Russell et al. 2009).

It seems inevitable that the construction industry will in the future need to acknowledge and act on the sustainability agenda with more commitment than it has shown thus far, not least because of increasingly stringent regulations and standards to mitigate the risk of dangerous climate change, but also to deal with environmental changes that are already taking place.

AIM OF THE RESEARCH

The aim of this research is to understand the nature of students' knowledge and understanding of sustainability in the contexts of their studies in Property, Construction and Project Management, and the perceived/stated needs of the industry. The following research questions were fundamental to achieve this aim:

- What are students' knowledge and understanding of a range of terms and concepts relating to sustainability?
- What patterns and trends, if any, are apparent in the nature of students' knowledge and understanding? Why do these arise?
- What, if any, are the stated/perceived needs of the construction industry, with specific reference to sustainability?
- Is there any relationship between student's knowledge and understanding of sustainability with respect to industry needs?

The outcomes of this research have pedagogical implications for the design of built environment curricula, particularly in relation to current and future needs of the construction industry.

For the purposes of this paper, sustainability relates primarily to environmental sustainability and specifically any impacts of the building industry that adversely affect the current and future state of the earth's natural resources – climate, water, land, air, flora, fauna and biodiversity. However, it is problematic to separate environmental sustainability from notions of ethics, morals, social justice and human well-being. Although this paper is concerned with education for sustainability in the built environment, the broader question of how sustainability is perceived and understood goes to the crux of assessing how the education system is performing in its attempts to produce graduates capable of and motivated to make the changes required and increasingly called for in the real world.

RESEARCH METHODS

Principle materials and methods for this research comprise student surveys undertaken in Melbourne and Singapore. As part of their undergraduate course, RMIT students of Construction Management, Property Management or Project Management at the School of Property, Construction and Project Management (PCPM) undertake a compulsory course in Research and Sustainability. The third year unit is one eighth of the required program and aims to introduce students to the concept of sustainability,

how it relates to the built environment, and the construction industry's role; and provide an introduction to methods used in construction management research.

The course is undertaken by students in Singapore and Melbourne in Semester 2 and presents the first formal opportunity for most students to learn about sustainability in more detail and as it relates specifically to their chosen disciplines. The course is delivered over 12 weeks in Melbourne and over 18 hours (10 evenings) in Singapore.

Approximately 3-4 weeks into the 2009 course for Melbourne students ('Pre' survey), and throughout the 10-day course for those in Singapore, students were invited to complete a survey exploring their perceptions, knowledge and understanding of sustainability. A total of 166 students in Melbourne and 80 students in Singapore took part in the survey. The on-line survey was hosted by 'Survey Monkey', a web-based service that automatically collates and carries out preliminary analyses of survey results. Melbourne students were invited to complete the same survey again at the end of the 12-week course ('Post' survey).

Student Surveys

The survey begins with rated response questions designed to explore the importance with which students regard sustainability for themselves, for their career, and as a political and moral issue. A series of conceptual questions follows, investigating the level and depth of students' understanding of key sustainability concepts including sustainable commercial building, sustainable construction, sustainable materials, and sustainable project management. Students are then asked to identify up to three building rating tools used to assess the sustainability of commercial buildings. Finally, students' perceived and actual capacity to correctly define certain common terms in sustainable construction is explored. These terms include green concrete, a carbon neutral building, green lease and life cycle assessment.

The survey evaluation includes both quantitative and qualitative data analysis. Preliminary analyses were conducted for each of the three survey groups separately, followed by a comparative analysis between groups. A comprehensive evaluation of survey methods and findings was conducted and the full report is available on request. For the purposes of this paper, only the key findings of this evaluation are presented.

RESULTS

For the Melbourne cohort of students, the results of the 'Post' compared with the 'Pre' survey show marginal improvement in students' understanding across all areas except the conceptual questions. However, differences in sample size and demographic make it difficult to draw any significant conclusions from this.

Comparing the 'Post' Melbourne and Singapore surveys, responses for the conceptual questions from Singapore students indicate less knowledge or appreciation of life-cycle processes. Regarding rating tools, Melbourne students are able to cite a wider range of specific assessment tools - 13 compared with 3 – indicating a lower awareness amongst Singapore students of even more widely known assessment tools from Japan, the UK, and US.

The key findings are as follows:

- The majority of students think that sustainability is either important or very important for each of the sub-questions, and most important for their future

careers. However, up to 8% of 'Post' Melbourne students still do not think it is important after completing the course.

- Responses to the conceptual questions suggest that many students are using certain common or learned terms and phrases generically, with no clear indication from their answer that they understand their meaning on a more personal level, e.g. sustainable/ility, green, 3 R's, future generations.
- There is evidence that for at least one question, and perhaps others, some students are transcribing their answer straight from course materials.
- 15-50% of students are unclear on the definitions of a Sustainable Building, Sustainable Construction and Sustainable Project Management and many students confuse the definitions of a Sustainable Commercial Building, Sustainable Construction and Sustainable Materials.
- A high proportion of students tend to define Sustainable Construction and Sustainable Materials only in terms of examples of certain features or examples of each, rather than what makes them sustainable.
- The majority of students have most difficulty in defining Sustainable Project Management.
- 1-13% of students could more comprehensively define the four terms.
- Over 50% of students were unable to name any assessment tools.
- Students in all three groups are most confident in their understanding of what defines a Carbon Neutral Building as compared with Green Concrete, Green Lease and Life Cycle Assessment. However, 57% of 'Post' Melbourne and 91% of Singapore students were unable to define it correctly.
- 57-90% of students could correctly define Green Concrete, Green Lease and Life Cycle Assessment.

In summary, there are no significant differences in the perceptions, knowledge and understanding of sustainability amongst third year Melbourne and Singapore students of PCPM. Melbourne results suggest that the Research and Sustainability course does increase students' knowledge of certain terms and concepts. However, results for all groups raise doubts regarding the degree to which students have integrated the notion of sustainability on a personal level, as an ethos to underlie their future careers, as opposed to being a body of knowledge, learned and applied when necessary. The next section examines this further.

DISCUSSION

An evaluation of the student surveys to the structure and stated aims of RMIT's Research and Sustainability course, and to the broader requirements of the construction industry is followed by implications for the future design of higher education construction curricula.

RMIT's Research and Sustainability course

Constituting one eighth of the curriculum in year three, and even less of the total four-year course, sustainability is not a significant course element for RMIT students of Property, Construction and Project Management. Short-term, the course could be seen to have achieved its aim to introduce students to the concept of sustainability and a range of methods used in construction management research. However, the student

survey was not designed to evaluate how well the course delivered this material, but rather the level of knowledge and understanding students have acquired as a result.

Survey analysis suggests a large degree of variation in how students are defining and understanding sustainability on a personal level, which has implications for evaluation. For example, although the majority of students regard sustainability as important or very important, subsequent responses indicate a lack of appreciation of any broader meaning of sustainability beyond basic technologies and phrases. The allocation of 'importance' in Question 1 is therefore called into question. In fact, the significant level of confusion regarding key concepts and terms even in the 'Post' Melbourne group, suggests that students are largely unaware of the importance of sustainability as it is defined in Section 3.

This lack of understanding/awareness is evident across both student groups with no indication that age is a contributory factor, although a more comprehensive analysis would be required to determine other potential contributory factors. The obvious common factor across the two groups is the Research and Sustainability course – the overarching characteristics of the course being that it comprises a small component of the total four-year course; is isolated as a separate unit; and introduces key sustainability concepts and terms.

It is perhaps not surprising that the level of importance that students perceive to be assigned to sustainability institutionally appears to be reflected in their own perception and understanding of the role it plays in their professional and personal lives. Its isolation and lack of integration throughout the four-year course encourages students to regard the delivered body of sustainability knowledge as separate from other course units, requiring just enough absorption to pass the course. The task of introducing key concepts and terms within such a short timeframe allows little opportunity to place them within a broader framework of sustainability, one that might encourage students to make a deeper and more personal connection with the associated themes and issues.

Survey responses do not indicate that students have a comprehensive understanding of sustainability issues or their relevance to all aspects of their chosen profession.

Industry Requirements

This section places the research undertaken in the context of attributes that the industry indicates it wants/needs in terms of future practitioners. Industry expectations are sourced largely through the literature review. There are potential pedagogical impacts regarding sustainability education for building and construction professionals, hence the survey undertaken needs to be placed within a wider context. It is assumed that in the future, meeting/anticipating increased policy and regulatory demands will become business as usual for the construction industry and form part of their 'wanted/needed' skill set of prospective employees.

The construction industry is seeking more adaptable and multi-skilled employees to cope with the changing and increasingly multi-disciplinary nature of construction projects. Future practitioners are expected to deal with labour shortages; environmental issues (energy, water and global warming); globalisation; productivity/efficiency improvements and changing corporate strategies (McDermott 2009).

Greater expertise in 'soft' skills is also called for. These include communication, leadership, teamwork, negotiation, management and analytical thought - all attributes of emotional intelligence, which is linked with social and environmental awareness. This means that students will not just need to become aware of sustainability issues,

but will need to be equipped with skills to enable them to cope in a rapidly changing industry.

Implications for Higher Education

To effectively foster a comprehensive understanding of the relevance of sustainability to their future professional lives, and a more meaningful connection with sustainability on a personal and aspirational level, educational institutions and the courses and curriculum they offer need to themselves reflect these values. They need to "walk and talk" sustainability, embedded as core values and aims throughout the education process, a view supported by the United Nations at the 2002 Earth Summit and endorsed by the Economic Commission for Europe (UN 2002, 2004, in Reid and Petocz 2006). This is contrary to the current modular approach where aspects and issues of sustainability are corralled and treated as add-ons to the main body of a course, an approach shown to inhibit the development of emotional intelligence, and the capacity for independent thought and critical analysis (Mo et al. 2007; Russell et al. 2007).

An integrated approach to aspects and issues of sustainability, encompassing culture, ethics, values and moral leadership, would elevate it from being another skill-set or learned body of knowledge, to a way of understanding and looking at the world and actions taken in it, a view supported by Elmualim (2008) and Reid and Petocz (2006).

Such level of institutional reform, requiring the development of a common language and understanding of sustainability at every level, takes time to evolve. However, as demonstrated by La Trobe University, it is possible to trial new curricula. Guided by a new set of aims and outcomes designed to address the apparent shortcomings of the current course, the sustainability component of RMIT's PCPM program may be modified to incorporate certain elements that have been shown to support:

- A broader understanding of sustainability on a professional level
- A deeper connection with sustainability at a personal level
- The capacity for independent thought, critical analysis and complex problem-solving

These elements include

- Supervised, small-scale, team-based building projects, or 'constructionarium' (a concept first conceived by Professor Chris Wise at Imperial College London in 2003) focusing on sustainability - two per course to embed 'best' practice.
- Industry experience – with awareness that this can instil 'bad' practice.
- Futuristic Reports – to encourage collaboration, critical thinking, social and environmental awareness.

Combined with efforts to reflect the meaning and importance of sustainability more effectively through all levels of university curricula, such changes in approach to construction education may assist all educational institutes to meet the current needs/desires of the construction industry in terms of their employees, but more importantly, prepare increasing numbers of graduates to be the instigators of industry changes that society and the environment demands.

CONCLUSION

Sustainability is not currently regarded as core business by the construction industry and, more often, prevalent practices are actively opposed to it. However, external

pressure for the industry to change is mounting and one of the key points of intervention is through the industry's key resource - its people.

The study undertaken demonstrated that while students may consider sustainability as important consideration for the future, they do not really understand the tools currently available to assist their sustainability goals. There was no difference in the general perceptions, understanding or knowledge of sustainability of students in Melbourne and Singapore.

Future graduates of the construction professions will be faced with increasingly complex situations, facing a world where sustainability will need to be incorporated at the core level of their thinking and practice. Sustainability does not constitute a prescriptive body of knowledge, but instead requires the application of broad principles and critical thinking to support a process of continuous learning where the practitioner bears a responsibility to build on and apply their learning from one project to the next.

Future graduates will have to possess the intellectual and emotional capacity for independent thought, critical analysis, creativity and complex problem-solving. To be instigators of change they will have to be literate in the broader moral, ethical and social implications of sustainability, and be motivated on a personal level through an aspirational connection with their own desired futures. Efforts should be made to move away from a modular or silo approach to sustainability education as has been the case with the current course curriculum at RMIT University. Instead, there needs to be a common theme through all courses and units, reflected not only in curriculum but all facets of the University as an institution. On such a foundation, students of construction will be better placed to situate their professional studies within a broader context, and, assisted by certain course elements such as constructionarium, industry experience and futures thinking, be capable of fulfilling the demands of the industry and motivated to be the instigators of industry change that society and environment demands.

REFERENCES

- CIOB (2004) Sustainability and Construction, Chartered Institute of Building, Ascot, www.cio.org.uk/filegrab/sustainability.pdf?ref=74. Accessed April 2010.
- DEH (2006) Scoping study to investigate measures for improving the environmental sustainability of building materials, Department of the Environment and Heritage, Commonwealth of Australia, Canberra, ACT, www.environment.gov.au/sustainability/energyefficiency/buildings/publications/building-materials.html. Accessed April 2010.
- Elmualim, A A (2008) Moral Leadership Education in Construction. In: Dainty, A (Ed) "24th Annual ARCOM Conference", 1-3 September 2008, Cardiff, UK, Association of Researchers in Construction Management, Vol. 1, 393-402.
- Ganah, A, Pye A and Hall, G (2008) The Role of Knowledge transfer in Sustainability Research in the Built Environment Discipline. In: Dainty, A (Ed), "24th Annual ARCOM Conference", 1-3 September 2008, Cardiff, UK, Association of Researchers in Construction Management, 299-307.

- Hill, C J, Howarth, T A P, McNamara, E T and Watson, P (1997) A TQM approach to construction education. In: Stephenson, P (Ed.), 13th Annual ARCOM Conference, 15-17 September 1997, King's College, Cambridge. Association of Researchers in Construction Management, Vol 2, 521-9.
- Howarth, T and Griffith, A (1998) Promoting Continuous Improvement in Construction Education: Developing Curricula Through Graduate-Practitioner Reflection. In: Hughes, W (Ed), "14th Annual ARCOM Conference", 9-11 September 1998, University of Reading. Association of Researchers in Construction Management, Vol 1, 15-21.
- Manthe, M and Smallwood, J (2007) The appropriateness of built environment tertiary education. "Journal of Engineering, Design and Technology", 5(2), 102-119.
- McDermott, C (2009) "The future of the construction industry and the implications for construction project management and education", Unpublished PhD Thesis, Department of Civil Engineering (Construction Engineering and Management), Iowa State University.
- Miller, S R (2005) Student Perceptions of the First Year Civil Engineering Course Content. "Journal of Engineering, Design and Technology", 3(2), 180-189.
- Mo, Y Y, Dainty, A and Price A (2007) An Assessment of the Emotional Intelligence of Construction Students: An Empirical Investigation. In: Boyd, D (Ed) "23rd Annual ARCOM Conference", 3-5 September 2007, Belfast, UK, Association of Researchers in Construction Management, Vol. 1, 325-334.
- Myers, D (2005) A review of construction companies' attitudes to sustainability. "Construction Management and Economics", Vol 23, 781-785.
- OECD (2003). Environmentally Sustainable Buildings: Challenges and Policies. Paris, OECD.
- Reid, A and Petocz, P (2006) University lecturers' understanding of sustainability. "Higher Education", Vol 51, 105-123.
- Russell, J, Legge, K and Petrolito, J (2009) A Multi-Disciplinary Approach to Introducing Environmental-Sustainability Concepts into a Civil Engineering Course. "20th Australasian Association for Engineering Education Conference", 6-9 December 2009, University of Adelaide, 789-794.
- Russell, J S, Hanna, A, Bank, LC and Shapira, A (2007) Education in Construction Engineering and Management Built on Tradition: Blueprint for Tomorrow. "Journal of Construction Engineering and Management", 133(9), 661-668.
- US Energy Information Administration (2009a) International Energy Annual 2006, Released June-December 2008, www.eia.doe.gov/iea/carbon.html. Accessed April 2010.
- US Energy Information Administration (2009b) International Energy Outlook 2009. Released 27 May, 2009, www.eia.doe.gov/oiaf/ieo/highlights.html. Accessed April 2010.
- Williams, A (2004) Industry Engagement in UK Built Environment Higher Education Courses. In: Khosrowshahi, F (Ed), "20th Annual ARCOM Conference", 1-3 September 2004, Heriot Watt University. Association of Researchers in Construction Management, Vol 1, 541-9.
- World Federation of Engineering Organisations (WFEO) (2006) WFEO Mission, www.wfeo.org/index.php?page=mission. Accessed April 2010.
- Yuhong Wang, P E (2009) Sustainability in Construction Education. "Journal of Professional Issues in Engineering Education and Practice", 135(1), 21-30.